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Squaring and adding these relations to eliminate β, we find

$$1=\sin^2\phi\,\cos^2\psi+\cos^2\phi\,\sec^2\xi,$$

and using (3) to reduce,

$$\begin{aligned}&\sec^2\phi=\tan^2\phi\,\cos^2\psi+1+\mu'^2\cos^2\psi\\&\tan^2\phi(1-\cos^2\psi)=\mu'^2\cos^2\psi,\text{ or}\\(6)\qquad&\tan\phi=\mu'\cot\psi.\end{aligned}$$

Taking moments about the top of the beam in the vertical plane containing the beam, calling the length $2L$, we have,

$$\begin{aligned}&2L\cos\beta\,x-2L\sin\beta\,\mu\,x-L\cos\beta\,W=0,\text{ or}\\&2(1-\mu\tan\beta)x-W=0;\\\text{or using (2),}\qquad&1-2\mu\tan\beta-\mu\mu'\sin\psi\cos\xi=0.\end{aligned}$$

Dividing (5) by (4) and using (6), we find, $\tan\beta=\dfrac{\mu'\cos^2\psi}{\sin\psi}\cos\xi$, which substituted, gives $\sec\xi=\mu\mu'(2\dfrac{\cos^2\psi}{\sin\psi}+\sin\psi)$, or by (3),

$$\surd(\mu'^2\cos^2\psi+1)=\mu\mu'(\frac{2-\sin^2\psi}{\sin\psi}).$$

Squaring, we easily find

$$(1+\mu^2)\mu'^2\sin^4\psi-(1+\mu'^2+4\mu^2\mu'^2)\sin^2\psi+4\mu^2\mu'^2=0.$$

260. Proposed by W. J. GREENSTREET, M. A., Stroud, England.

To the ends of a fine inextensible string, length $2l$, are attached to equal, smooth, spherical, equally elastic (e) particles. At first the middle point of the string touches a rigid, fixed, circular rim, radius a, and the particles are $2l$ apart. They are now projected with equal velocities perpendicular to the string and curl around the rim. If l is greater than πa, find the condition that the particles will move after collision along tangents to the rim, the whole motion being on a smooth horizontal plane.

Solution by H. PRIME, Boston, Massachusetts.

Let P be the middle of the string, Q the point of impact, O the center of the rim, R the point of tangency with the string at the moment of impact and AB the normal through Q; θ and ϕ the angles which the velocities make with *AB* before and after impact; u and v the components of the velocities along *AB* before and after impact. The tangential components of these velocities (along *QP*) before and after impact are $u\tan\theta$ and $v\tan\phi$, which are unchanged by the impact, since the contact is smooth. Hence it must be that $u\tan\theta = v\tan\phi$, or since $v=eu$, $\tan\theta = e\tan\phi$. Also since the string tangent to the rim is a normal to its involute, $\theta+\phi=90^\circ$ and $\tan\phi=\cot\theta$. Hence $\tan\theta=\sqrt{e}$. But $\theta=PQR$ and $POR=90^\circ+\theta$. Therefore the required condition is $l=a(\pi/2+\tan^{-1}\sqrt{e}+1/\sqrt{e})$.

Also solved by S. G. Barton.

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PROBLEMS FOR SOLUTION.

ALGEBRA.

374. Proposed by H. PRIME, Boston, Massachusetts.

Divide an angle of 30° into two parts so that the product of the third and fourth powers of their sines (or cosines) shall be a maximum. To be solved without using the methods of calculus. [From *The Maine Farmers' Almanac*, 1912.]

375. Propǒsed by S. LEFSCHETZ, University of Nebraska.

Prove that $\frac{e}{2m+2} < e - (1+\frac{1}{m})^m < \frac{e}{2m+1}$. [Schlömilch.]

376. Proposed by W. W. BEMAN, Professor of Mathematics, University of Michigan, Ann Arbor, Michigan.

If $\frac{(1+1/m)^m}{e} = 1 - a_1\frac{1}{m} + a_2\frac{1}{m^2} - a_3\frac{1}{m^3} + \ldots$, prove $na_n = \sum_{k=1}^{k=n} \frac{k}{k+1} a_{n-k}$, and compute $a_1, a_2, a_3, \ldots, a_n$.

GEOMETRY.

403. Proposed by C. E. GITHENS, Wheeling, West Virginia.

In a triangular field the sides enclosing an obtuse angle are 35 rods and 48 rods in length, Two straight lines are drawn from this vertex, and are at right angles to these sides. If these lines intersect the base 16 rods apart, how long is the third side of the field?

404. Proposed by S. LEFSCHETZ, Ph. D., University of Nebraska.

Let *ABC* be a triangle, *M* a point on *BC*, *BE* the intersection of the perpendicular to *AM* in *M* with *AB* and *AC*, *F*, the other intersection of the circle circumscribed to *ABC* with the circle through *M* and *A* orthogonal to it in *A*. Prove that the points *C*, *D*, *E*, *F* are on a circle, and find the envelope of the latter when *M* describes *BC*.

405. Proposed by C. N. SCHMALL, New York City.

A plane cuts a constant volume from a given right cone. Prove that the minor axis of the section has a constant length.